INDOOR AIR QUALITY ASSESSMENT

Brimfield Elementary School
22 Wales Road
Brimfield, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
May 2004

Background/Introduction

At the request of Mr. Peter Silverman, Principal of Brimfield Elementary School, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Brimfield Elementary School (BES), 22 Wales Road, Brimfield, Massachusetts. A visit to conduct an indoor air quality assessment was made to this school by Cory Holmes, Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) Program on December 11, 2003. The request was prompted by concerns about mold in the primary wing that resulted from flooding as well as prolonged humid weather experienced during the first three weeks of August 2003.

The school is a multi-level brick building originally constructed in the early 1900's. The primary wing was added in the 1970's. The school contains general classrooms, science classrooms, music/band rooms, a kitchen, cafeteria, gymnasium, library, health suite and office space. School officials reported that the school has instituted a 5-year carpet replacement plan. Carpets in six to eight rooms are to be replaced each year. Over the course of 5 years, all carpets throughout the BES are planned to be replaced.

Methods

BEHA staff performed visual inspection of building materials for water damage and/or microbial growth. Moisture content of carpeting was measured with a Delmhorst, BD-2000 Model, Moisture Detector equipped with a Delmhorst Standard Probe. Air tests for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

This school houses approximately 350 students in kindergarten to grade 6 and a staff of approximately 45. Tests were taken during normal operations at the school and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in eight of thirty-three areas surveyed, indicating inadequate ventilation in some areas surveyed. Fresh air in classrooms is supplied by a unit ventilator (univent) system. Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building (Picture 1) and return air through an air intake located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated and provided to classrooms through an air diffuser located in the top of the unit. The majority of univents were operating during the assessment. Obstructions to airflow, such as papers and books stored on univents and items placed in front of univent returns, were seen in a number of classrooms (Picture 2). In order for univents to provide fresh air as designed, these units must remain activated and allowed to operate while rooms are occupied. In addition, intakes must remain free of obstructions.

Exhaust ventilation in classrooms consists of ceiling and/or wall-mounted vents powered by rooftop motors. The exhaust system was not drawing and/or was backdrafting in a number of areas surveyed, indicating that motors were deactivated or non-functional. Without adequate exhaust ventilation, excess heat and environmental pollutants can accumulate and lead to indoor air complaints. Items were also seen obstructing exhaust vents in classrooms (Picture 3). As with the univents, exhaust vents must be activated and remain free of obstructions to function as designed.

In order to have proper ventilation with a mechanical supply and exhaust system, ventilation systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week based on a time weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information on carbon dioxide see Appendix A.

Temperature readings ranged from 69 ^{o} F to 76 ^{o} F, which were very close to the BEHA comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. A number of temperature control/comfort complaints were expressed by occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. It is also difficult to control temperature and maintain comfort without operating the ventilation equipment as designed (e.g., univents obstructed, exhaust vents obstructed/not operating).

Relative humidity measurements ranged from 33 to 50 percent, which were below the BEHA comfort range in some areas. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

In the experience of BEHA staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. Relative humidity in excess of 70 percent can provide an environment for mold and fungal growth (ASHRAE, 1989). In general, materials that are prone to mold growth can become colonized when moistened for more than 24 to 48 hours. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August (The Weather Underground, 2003), materials in many schools and buildings were moistened for an extended period of time. As a result of this humidity, mold growth occurred in this building in two basement classrooms on the surface of carpeting. As previously mentioned, flooding in the primary wing also resulted in damage to carpets. Carpets were reportedly replaced or decontaminated with a fungicide. No evidence of active mold growth, elevated moisture content in carpeting or associated odors were detected by BEHA staff at the time of the assessment.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24-48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

The building is equipped with gutters and downspouts to drain rainwater away from the building. Several downspouts were missing elbows causing water to empty and pool against the foundation (Picture 4). Excessive exposure to water of exterior brickwork can result in damage over time. During winter weather, the freezing and thawing of moisture in bricks can accelerate the deterioration of brickwork, which can lead to water intrusion into the interior of the building.

A number of areas had water-stained ceiling tiles, which can indicate leaks from the roof or plumbing system. An active leak was observed in the hallway near the kitchen during the assessment. An empty can was placed within the ceiling tile system to catch dripping rainwater that was penetrating through the roof (Picture 5). Water-damaged porous building materials can provide a source for mold and should be replaced after a water leak is discovered and repaired.

Spaces between the sink countertop and backsplash were noted in several areas (Table 1/Picture 6). Improper drainage or sink overflow can lead to water penetration of countertop wood, the cabinet interior and behind cabinets. If porous materials become wet repeatedly they can provide a medium for mold growth.

Several classrooms had a number of plants. Moistened plant soil and drip pans can be a source of mold growth. Plants are also a source of pollen. Plants should be located away from the air stream of ventilation sources to prevent the aerosolization of mold, pollen or particulate matter throughout the classroom (Picture 7). Plants and shrubbery were also noted outside the building in close proximity to univent air intakes (Picture 8). Plants and shrubbery should be located approximately five feet away from the building to prevent entrainment of pollen and/or moisture.

Signs of bird roosting and nesting materials were observed in a school bell directly above an air intake for a second floor univent (Picture 1). BEHA staff recommended that the nest be removed to prevent entrainment of bird wastes. Birds can be a source of disease, and bird wastes and feathers can contain mold and mildew, which can be irritating to the respiratory system. No obvious signs of bird roosting inside the building were noted by BEHA staff nor were such signs reported by occupants.

Other Concerns

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants; however, the pollutant produced is dependent on the material combusted. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, BEHA staff obtained measurements for carbon monoxide and PM2.5. Outdoor carbon monoxide concentrations were non-detect or ND (Table 1). Carbon monoxide levels measured in the school were also ND.

Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions of reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient-Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000).

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. *Carbon monoxide should not be present in a typical, indoor environment.* If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels.

The NAAQS originally established exposure limits for particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average. This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average. Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, BEHA uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment. Outdoor PM2.5 concentrations were measured at 9 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 2 to 9 $\mu g/m^3$, which reflected outdoor levels and were well below the NAAQS of 65 $\mu g/m^3$.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were non-detect (ND) (Table 1). Indoor TVOC measurements throughout the building were also ND.

Please note, that the TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use TVOC containing products (e.g., use of product increases the concentration of TVOC within a classroom).

In an effort to identify materials that can potentially increase indoor TVOC concentrations, BEHA staff examined classrooms for products containing these respiratory irritants. The media center contained two photocopiers, a lamination machine and a mimeograph machine with several containers of duplicating fluid (Picture 9). The faculty workroom contains three photocopiers and two lamination machines. Lamination machines can produce irritating odors during use. Mimeograph duplicating fluid contains methanol (methyl alcohol), which is a volatile organic compound that readily evaporates at room temperature. The off gassing of this material can be irritating to the eyes, nose and throat. Methanol is also a highly flammable material, which can be ignited by either flame or electrical source. Lamination machines can produce irritating odors during use. VOCs and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, 1992). To help reduce excess heat and odors in these areas, school personnel should ensure that local exhaust ventilation is activated while equipment is in use.

A strong chemical-like odor was detected in the men's and woman's restrooms. The source of this odor appeared to be plug-in type air fresheners. The ventilation system was drawing weakly in this area during the assessment; therefore there was minimal removal of this odor via the exhaust vent. Lack of removal results in the accumulation of the fragrance. Air fresheners contain chemicals that can be irritating to the eyes, nose and throat of sensitive individuals. Furthermore, air fresheners do not remove the source causing odors, but rather mask odors that may be present in the area.

Several classrooms contained dry erase boards and dry erase markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs (e.g., methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve) (Sanford, 1999), which can be irritating to the eyes, nose and throat.

Spray-cleaning products were found on countertops and in unlocked storage cabinets beneath sinks in classrooms (Picture 10). Cleaning products contain chemicals that can be irritating to the eyes, nose and throat. Cleaning products should be stored properly and kept out of reach of students.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs (Picture 11). Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and lead to off-gassing of VOCs. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Also of note was the amount of materials stored inside classrooms. In classrooms throughout the school, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored in classrooms provide a source for dusts to accumulate. These items, (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up. Accumulated dust was also observed on classroom exhaust vents and personal fans (Picture 12). Exhaust vents and personal fans should be cleaned periodically to avoid aerosolizing accumulated dust.

Several rooms had various objects hung from the ceiling tile system (Picture 13). The movement of ceiling tiles can provide a pathway for drafts, dusts and particulate matter between rooms and floors. Building occupants should refrain from hanging objects to prevent unnecessary strain to ceiling tile system.

Conclusions/Recommendations

In view of the findings at the time of the assessment, the following recommendations are made:

1. Survey classroom univents to ascertain function and determine whether an adequate air supply exists for each room. Consider consulting a heating, ventilation and air conditioning (HVAC) engineer concerning the calibration of univent fresh air control dampers throughout the school.
2. Operate all ventilation systems throughout the building (e.g., gym, auditorium, classrooms) continuously during periods of school occupancy and independent of thermostat control to maximize air exchange. To increase airflow in classrooms, set univent controls to “high”.
3. Inspect rooftop exhaust motors and belts for proper function, repair and replace as necessary.
4. Remove all blockages from univents and exhaust vents.
5. Consider balancing mechanical ventilation systems every 5 years, as recommended by ventilation industrial standards (SMACNA, 1994).
6. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to

minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).

7. Remove bird's nests from vicinity of univent air intake (Picture 1). Inspect to ensure surfaces are free of nesting materials and bird wastes. Clean and disinfect intake vents with an appropriate antimicrobial where necessary.
8. Install elbow extensions on downspouts to direct rain water away from the building.
9. Replace any water-damaged ceiling tiles, once leaks are repaired. Examine the area above and beneath these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial. Clean areas of antimicrobial application when dry.
10. Replace missing or damaged caulking between countertops and sinks. Observe interior of cabinets for water-damage and mold growth. Disinfect with an appropriate antimicrobial where necessary.
11. Replace any missing/damaged ceiling tiles, to prevent the egress of dirt, dust and particulate matter into classrooms. Refrain from hanging objects from ceiling tile system.
12. Remove plants away from univents. Ensure plants have drip pans. Examine drip pans periodically for mold growth and disinfect with an appropriate antimicrobial where necessary.
13. Continue with plans to replace carpets throughout the school.

14. Ensure local exhaust is operating in the media center workroom to remove excess heat and odors from office machines. Consider discontinuing use of the mimeograph machine.
15. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
16. Consider discontinuing the use of tennis balls on chairs to prevent latex dust generation.
17. Store cleaning products and chemicals properly and keep out of reach of students.
18. Clean personal fans and exhaust vents periodically to prevent excessive dust build-up.
19. Refrain from using strongly scented materials (e.g., air fresheners) in classrooms.
20. Consider adopting the US EPA (2000) document, Tools for Schools, in order to provide self assessment and maintain a good indoor air quality environment at your building. The document is available at http://www.epa.gov/iaq/schools/index.html.
21. Consult "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001), for further information on mold. Remediation of mold contaminated materials should be conducted in a manner consistent with this document. Copies of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html.
22. Refer to the resource manual and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. These documents are located on the MDPH's website: http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

References

ACGIH. 1989. Guidelines for the Assessment of Bioaerosols in the Indoor Environment. American Conference of Governmental Industrial Hygienists, Cincinnati, OH.

ASHRAE. 1989. Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigeration and Air Conditioning Engineers. ANSI/ASHRAE 62-1989

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

MDPH. 1997. Requirements to Maintain Air Quality in Indoor Skating Rinks (State Sanitary Code, Chapter XI). 105 CMR 675.000. Massachusetts Department of Public Health, Boston, MA.

NIOSH. 1997. NIOSH Alert Preventing Allergic Reactions to Natural Rubber latex in the Workplace. National Institute for Occupational Safety and Health, Atlanta, GA.

NIOSH. 1998. Latex Allergy: A Prevention Guide. National Institute for Occupational Safety and Health, Atlanta, GA.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

Sanford. 1999. Material Safety Data Sheet (MSDS No: 198-17). Expo® Dry Erase Markers Bullet, Chisel, and Ultra Fine Tip. Sanford Corporation. Bellwood, IL.

SBAA. 2001. Latex In the Home And Community Updated Spring 2001. Spina Bifida Association of America, Washington, DC. Http://www.sbaa.org/html/sbaa_mlatex.html

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

Schmidt Etkin, D. 1992. Office Furnishings/Equipment & IAQ Health Impacts, Prevention & Mitigation. Cutter Information Corporation, Indoor Air Quality Update, Arlington, MA.

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

US EPA. 2001. "Mold Remediation in Schools and Commercial Buildings". Office of Air and Radiation, Indoor Environments Division, Washington, DC. EPA 402-K-01-001. March 2001. Available at: http://www.epa.gov/iaq/molds/mold_remediation.html

US EPA. 2000. National Ambient Air Quality Standards (NAAQS). . US Environmental Protection Agency, Office of Air Quality Planning and Standards, Washington, DC. http://www.epa.gov/air/criteria.html.

Weather Underground, The. 2003. Weather History for Massachusetts, August 1, 2003 through August 13, 2003. http://www.wunderground.com/history/

Picture 1

Univent Fresh Air Intake, Note Bird's Nest Over Vent

Picture 2

Univent Obstructed by Furniture and Other Items

Picture 3

Items Stored on top of Storage Cabinet Obstructing Ceiling Exhaust Vent

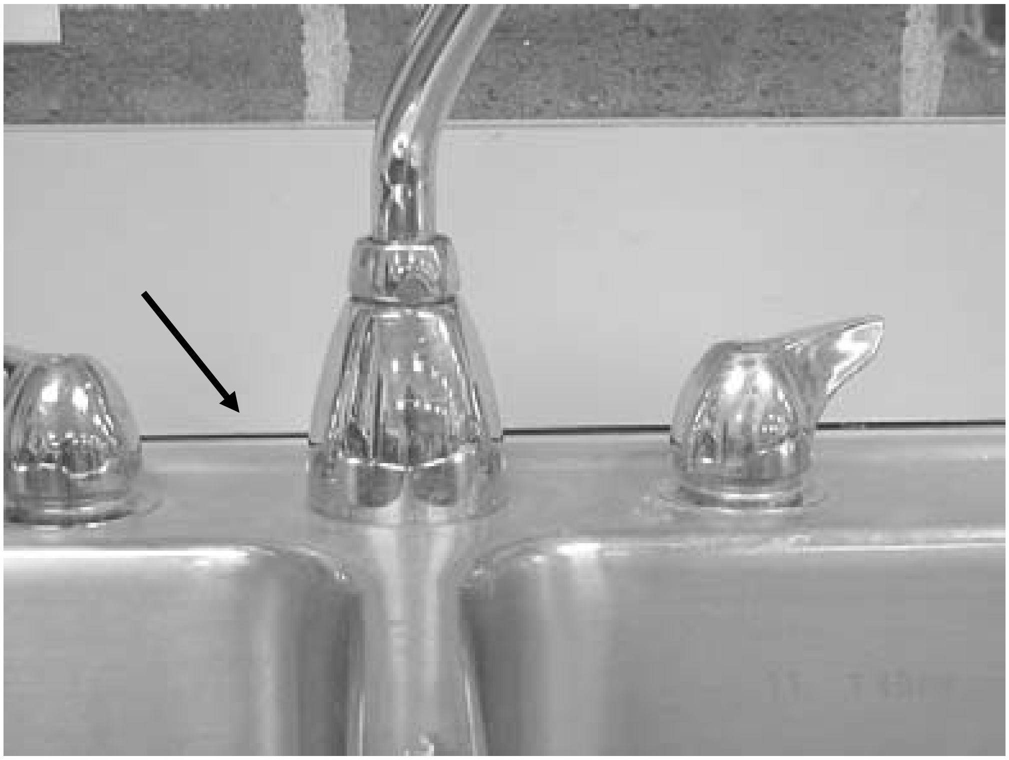
Picture 4

Downspout With Missing Elbow Empting Water against the Foundation

Picture 5

Empty Can Stationed above Ceiling Tile System to Catch Leak

Picture 6

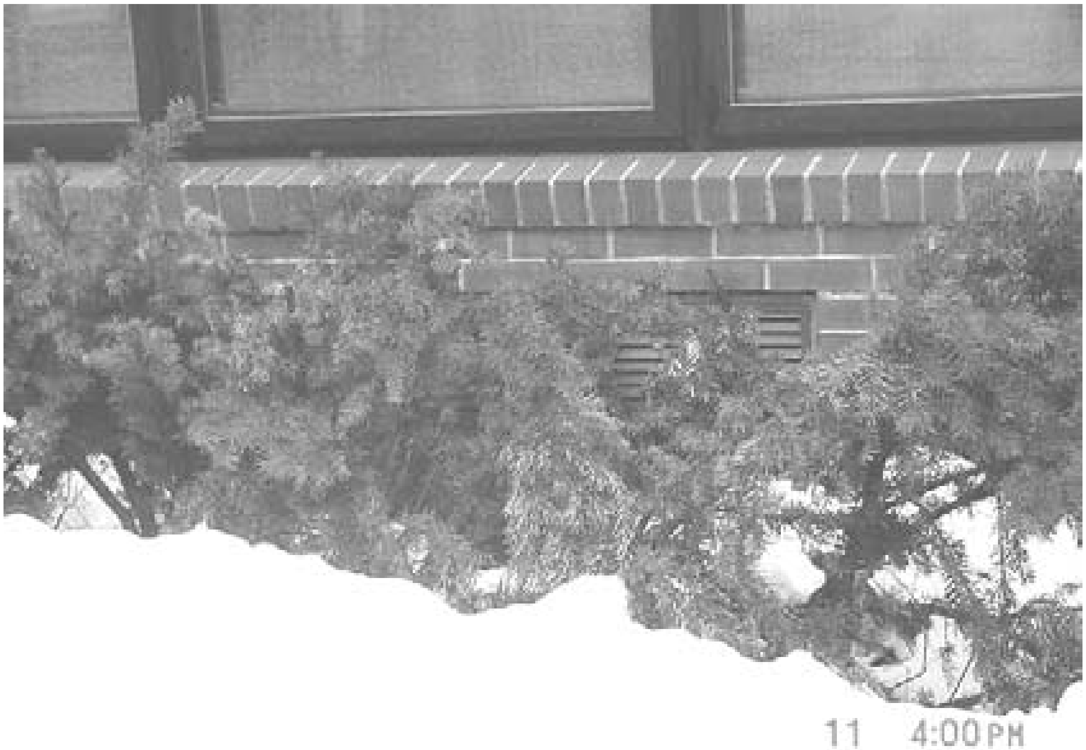


Spaces between Sink Countertop and Backsplash

Picture 7

Plants on and above Classroom Univent

Picture 8



Plants/Shrubbery in Close Proximity to Univent Air Intake

Picture 9

Mimeograph Machine and Containers of Duplicating Fluid

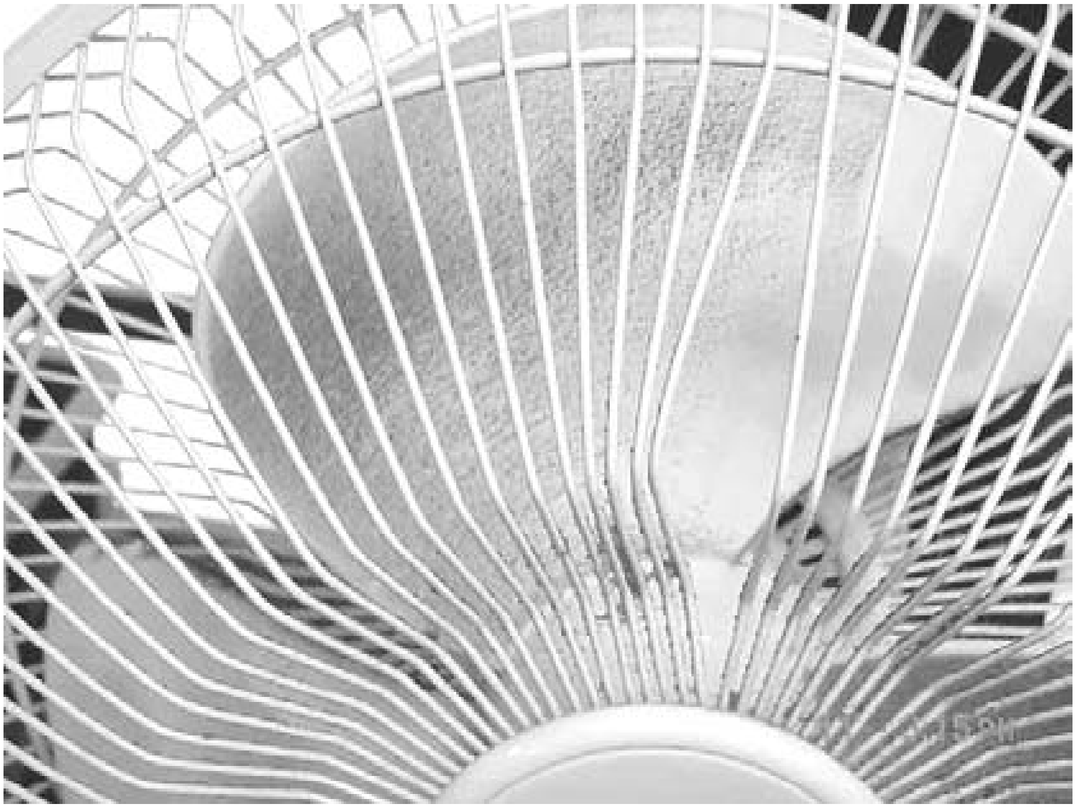
Picture 10

Cleaning Products Under Classroom Sink

Picture 11

Tennis Balls on Chair Legs

Picture 12



Accumulated Dust on Personal Fan in Classroom

Picture 13

Items Hanging From Ceiling Tile System

Brimfield Elementary School | **Indoor Air Results**

22 Wales Road, Brimfield, MA | **December 11, 2003**

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Background (outdoors)	57	53	324	ND	ND	9	-	-	-	-	Heavy rain, SE winds 15-20 mph
155	72	39	719	ND	ND	7	18	Y	Y	Y	DO, feather duster, items hanging from CT system, dust accumulation on PF, cleaning products, accumulated items in classroom, plants
156	72	39	1538	ND	ND	8	15	Y	Y	Y	Exhaust not operating, UV blocked by items, cleaning products, items hanging from CT system, spaces around sink/backsplash
159	73	38	893	ND	ND	7	9	Y	Y	Y	DO, exhaust vent blocked, cleaning products
118 Music	72	39	630	ND	ND	3	16	Y	Y	Y	
116	73	37	605	ND	ND	3	7	Y	Y	Y	Cobwebs near windowsill, DEM

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier

CD = chalk dust
DEM = dry erase marker
DO = door open
ND = non detect
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
UV = univent

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

Brimfield Elementary School

22 Wales Road, Brimfield, MA

Table 1

Indoor Air Results

December 11, 2003

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation Supply	Ventilation Exhaust	Remarks
115	74	40	465	ND	ND	2	3	Y	Y	Y	
114	74	39	618	ND	ND	6	14	Y	Y	Y	DO
182 Computer Room	76	36	478	ND	ND	3	1	Y	Y	Y	DEM, AC, 23 computers and related equipment, feather duster on UV
183	73	34	607	ND	ND	5	16	Y	Y	Y	Feather duster
Faculty mens RR									Y	Y	Exhaust not operating
Cafeteria	71	38	721	ND	ND	7	75	N	Y	Y	2 AHUs on roof, DO
113	75	40	888	ND	ND	5	15	Y	Y	Y	Exhaust off-backdrafting, DO

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier

CD = chalk dust
DEM = dry erase marker
DO = door open
ND = non detect
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Brimfield Elementary School

22 Wales Road, Brimfield, MA

Indoor Air Results

December 11, 2003

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
121	73	33	593	ND	ND	2	0	Y	Y	Y	UV and exhaust vent off, plants on UV
120	73	34	581	ND	ND	2	0	Y	Y	Y	Plants on UV, cleaning products
Mens/ Womens Restrooms									Y	Y	Exhaust weak, plug in air fresheners-strong odors
216	71	44	534	ND	ND	6	0	Y	Y	Y	PF-dust, DO, plants on UV, TB, DEM
218	70	37	486	ND	ND	5	0	Y	Y	Y	
283	73	44	605	ND	ND	8	15	Y	Y	Y	DO, dust-exhaust vent, feather duster on UV, AC, heat complaints, items hanging from CT system

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier

CD = chalk dust
DEM = dry erase marker
DO = door open
ND = non detect
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Brimfield Elementary School

22 Wales Road, Brimfield, MA

Table 1

Indoor Air Results

December 11, 2003

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
282	71	39	1346	ND	ND	7		Y	Y	Y	AC, PF
214	73	44	667	ND	ND	3	15	Y	Y	Y	DEM
219	71	37	667	ND	ND	7	0	Y	Y	Y	Dust accumulation-exhaust vents
213	72	43	670	ND	ND	3		Y	Y	Y	DO, exhaust off, plants on UV, tank with standing water, carpet stains-low moisture content, DEM
220	72	39	688	ND	ND	7	1	Y	Y	Y	Heat complaints-UV deactivated
160	74	38	594	ND	ND	7	16	Y	Y	Y	Exhaust off, items hanging from CT system
158	74	37	1244	ND	ND	9	12	Y	Y	Y	DO, exhaust off/blocked, UV obstructed by furniture, cold complaints-teacher's desk near UV

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier

CD = chalk dust
DEM = dry erase marker
DO = door open
ND = non detect
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Brimfield Elementary School

22 Wales Road, Brimfield, MA

Table 1

Indoor Air Results

December 11, 2003

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (µg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
170	71	33	680	ND	ND	5	2	Y	Y	Y	DO, plants
157	74	36	1600	ND	ND	6	15	Y	Y	Y	Exhaust off, items hanging from CT system
210	71	45	1477	ND	ND	6	16	Y	Y	Y	Items hanging from CT system, plants on UV, exhaust off
212	74	45	1095	ND	ND	4	15	Y	Y	Y	Items hanging from CT system, exhaust off, plants on UV, UV obstructed by furniture
110	69	38	361	ND	ND	2	2	Y	Y	Y	Exhaust off
112	71	50	782	ND	ND	5	16	Y	Y	Y	DEM
166	70	37	720	ND	ND	5	13	Y	Y	Y	Plants on UV, exhaust weak, UV obstructed by furniture

ppm = parts per million parts of air
µg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier

CD = chalk dust
DEM = dry erase marker
DO = door open
ND = non detect
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

Brimfield Elementary School

22 Wales Road, Brimfield, MA

Indoor Air Results

December 11, 2003

Table 1

Location/ Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (*ppm)	Carbon Monoxide (*ppm)	TVOCs (*ppm)	PM2.5 (μg/m3)	Occupants in Room	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
163	70	39	535	ND	ND	6	11	Y	Y	Y	Plants on UV and hanging from CT system, spaces sink/backsplash
Nurse's Office	72	39	668	ND	ND		4	Y	N	Y	1 CT
Media Centre	75	36	420	ND	ND	3	4	Y	Y	Y	Mimeograph machine-2 containers of duplicating fluid, 2 photocopiers, lamination machine, rizograph, 1 CT

ppm = parts per million parts of air
μg/m3 = microgram per cubic meter

AD = air deodorizer
AP = air purifier

CD = chalk dust
DEM = dry erase marker
DO = door open
ND = non detect
PC = photocopier

PF = personal fan
TB = tennis balls
UF = upholstered furniture
UV = univent

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%